A STUDY OF PENETRATING

ABDOMINAL INJURIES

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CERTIFICATE

This is to certify that this dissertation entitled **"A STUDY OF ABDOMINAL PENETRATING INJURIES"** submitted by **Dr.G. BALAKRISHNAN** to The Tamil Nadu Dr.M.G.R. Medical University, Chennai is in partial fulfillment of the requirement for the award of M.S. degree Branch I (General Surgery) and is a bonafide research work carried out by him under direct supervision and guidance.

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DECLARATION

I, Dr. G. Balakrishnan declare that I carried out this work on **"A STUDY OF ABDOMINAL PENETRATING INJURIES"** at Department of General Surgery, Government Rajaji Hospital during the period of January 2005 – January 2006. I also declare this bonafide work or a part of this work was not submitted by me or any other for any award, degree, diploma to any university, board either in India or abroad.

This is submitted to the Tamilnadu Dr.M.G.R. Medical University, Chennai in partial fulfillment of the rules and regulation for the M.S. Degree examination in General Surgery.

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INTRODUCTION

Trauma is a major worldwide public health problem. It is one of the leading causes of death and disability in both industrialized and developing countries. High speed vehicles, decivilization of human race, terrorism and sports are just few of the predisposing factors of trauma. Evaluation of a patient with abdominal trauma can be a most challenging task that a surgeon may be called upon to deal with. Abdominal injuries may be parietal or visceral injuries. Visceral injuries may be intraperitoneal or retroperitoneal Liver, spleen, stomach, small bowel, duodenum, Large bowel, pancreas, Kidney, ureter and retroperitoneal vasculature are the organs included in this study and pelvic organs are excluded. Multi organ injuries, exsanguinating hemorrhages delayed presentations and the ominous reputation for high mortality and morbidity are just few of the many reasons which makes this topic of penetrating injuries a fascinating one.

REVIEW OF ANATOMY[1,23]

A revision of the surgical anatomy of the abdominal organs is necessary at this juncture to appreciate the various aspects of penetrating abdominal injuries. For evaluation purposes the abdomen is divided into four areas intrathoracic abdomen, true abdomen, pelvic abdomen, and retroperitoneal abdomen.

The intrathoracic abdomen is that portion of the upper abdomen that lies beneath the rib cage. The contents include the diaphragm, liver, spleen and stomach. Peritoneal lavage becomes useful in evaluating this area.

The pelvic abdomen lies in the hollow of the pelvis. It is surrounded on all sides by the bony pelvis and its contents include the rectum, bladder, urethra small bowel and in females the uterus, fallopian tubes and ovaries. Penetrating injuries of the buttocks may injure the pelvic organs.

The retroperitoneal abdomen contains the kidneys, ureter, pancreas, second and third portion of the duodenum, the ascending and descending colon and the great vessels the aorta and vena cava. Evaluation of the retroperitoneal abdomen requires utilization of radiographic procedures including intravenous pyelography, angiography and CT.

The true abdomen contains the small and large intestines, the bladder when distended and uterus when gravid. Injuries to any of these organs are usually manifested by pain and peritonitis. Peritoneal lavage is useful adjunct when abdominal film may be helpful when free air is present.

LIVER

The liver is the largest gland in the body weighs about 1500 gms and receives 1500 ml of blood per minute, developed from ventral mesogastrium Liver has two surfaces diaphragmatic and visceral surfaces. The diaphragmatic surface is subdivided into anterior, superior, posterior and right surfaces. Liver is held in position by attachment of IVC and hepatic veins. The falciform ligamentum divides the anatomical left and Right lobes. Caudate Lobe lies back between Inferior venacava and the fissure for the ligamentum venosum. Quadrate Lobe lies between gall bladder fossa and the fissure for the ligamentum teres on the basis of blood supply and biliary drainage. Liver is divided into four anatomical segments in eight sectors. Blood supply is by hepatic artery and portal vein supplying 25% and 75% of total blood supply by supplying 50% oxygen each and drained by Right middle and Left hepatic veins and also about 10 to 15 small veins drain directly into IVC. The ligament which are attached to the liver are right and left triangular ligament, coronary ligament and lesser omentum. Hepatic artery, common bile duct and

portal vein passes through the free border of lesser omentum. Pringle's maneuver is the temporary application of vascular clamp to the free margin of lesser omentum upto a period of 20mts to 1 hour, indicated in major bleeding from hepatic or perihepatic injury so that bleeding points can be arrested by topical cooling.

SPLEEN

Spleen is the largest lymphoid organ in the body developed from dorsal mesoqastrium. It lies under diaphragm on the left side of the abdomen closely in contact with 9^{th}, 10^{th}, and 11^{th} ribs. It measures 1x 3x5 inches weighs 7oz. Spleen is freely mobile organ and held in position by lienorenal ligament and gastrosplenic ligament, phrenocolic ligament gives additional support. Spleen is supplied by spleenic artery passes between the layers of lienorenal ligament. At the hilum it breaks up into four branches which enter hilum separately. Similar veins leave the hilum and unit to form the splenic vein. The hilum of spleen is closely related to the tail of pancreas. So concomitant pancreatic and splenic injuries are common.

Spleen act as an immunological filter. It produces opsonin, tuftsin – a tetra peptide that coats white cells to promote phagocytosis of particular matter, bacteria and aged red cells. It is also a source of properdin, a vital component of alternative pathway of complement activation.

STOMACH

Stomach is the most dilated part of the alimentary tract, interposed between the esophagus and duodenum in the upper part of abdominal cavity and Lying mainly in the left hypochondrial, epigastric and umbilical regions with much of it under cover of the lower ribs. It is loosely suspended in the abdomen by the gastro hepatic ligament superiorly, the gastrocolic ligament inferiorly and by its attachment to the spleen laterally. It is relatively fixed at the gastro esophageal junction and the retroperitoneal duodenum. The gastric wall consist of an external serosal layer followed by three layers of smooth muscle outer longitudinal layer, middle circular layer, and inner oblique layer. A strong sub mucosal layer is followed by a mucosal layer with a rich capillary network. This network is supplied by arterioles, which originate in the sub mucosa.

The stomach is supplied by four major nutrient arteries with extensive collateral circulation between the vascular beds. The left gastric artery most commonly arises from the celiac axis and usually splits into anterior and posterior trunks before it reaches the stomach. Branches from the left gastric artery supply the distal esophagus and cardiac portion of the stomach. The right gastric artery most commonly originates from the hepatic Artery and it anastamoses with the left gastric circulation along the lesser curvature. The

left gastroepiploic artery is a collateral of the splenic artery and supplies the greater curvature. It anastamoses with right gastroepiploicartery in about 75% of cases. The more maximal portion of greater curvature is supplied by the short gastric vessels which originate from the gastroepiploic artery as well as from the splenic artery. The right gastroepiploic artery arises from the gastro duodenal artery and supplies the pyloric area and distal greater curvature. Venous drainage from the lesser curvature is via the coronary vein to the portal vein. On the greater curvature drainage is via the short gastric vessels and right and left gastroepiploic veins to the splenic vein.

SMALL INTESTINE

The small intestine consists of the duodenum, jejunum and Ileum. The Duodenum extends from the pylorus, lies opposite to the right side of the spine at the level of the first lumbar vertebra to the duodenojejunal flexure. It is ‘C’ shaped tube and about 25cm Long. It is divided into four parts and properly called as superior, descending, horizontal and ascending but simply called first, second, third and fourth parts of duodenum. The blood supply to the duodenum is from the celiac and superior mesenteric vessels. The first portion of the duodenum is intraperitoneal and some what mobile. The remainder of the duodenum is retroperitoneal owing to the fusion of the posterior peritoneum with the duodenum. The second and right half of the

third portion of the duodenum may be easily mobilized through this blood less fusion plane, a Kocher's maneuver. An additional point of fixation occurs at the ligament of Treitz.

Jejunum is wider bored and thicker walled than ileum. Jejunum and Ileum together lie in the free margin of the mesentery. Total length varies greatly from about 4 to 6 metres. The jejunum constitutes two fifths and three fifths for the ileum. Fan shaped mesentery suspends the small bowel and extends from the left side of the second lumber vertebrae downward to the right sacroiliac joint, the traversing the transverse colon, duodenum, Aorta, Inferior venacava, right gonadal vessels and Right writer. The superior Mesentric Artery supplies the jejunum and Ileum arising from the aorta approximately 2 cm below the celiac trunk after crossing the uncinate process of the pancreas, it enters root of the mesentery giving off branches to pancreas right colic and numerous intestinal vessels before it terminates at the medial aspect of the caecum.

PANCREAS

The pancreas lies transversely across the upper part of the posterior abdominal wall and is about 15-20 cm in length, 3.1cm in width, 1-1.5 cm in thickness and weights about 80-90gms. Posterior the pancreas is the IVC, Aorta, left Kidney, both renal vein and the right renal Artery. The pancreatic

head lies with in the concave sweep of the duodenum. The splenic artery runs along the upper border of the pancreas and the splenic vein runs behind, Just superior to the lower edge. The superior mesenteric vein and artery lies just behind the neck of the pancreas and are also enclosed posteriorly by an extension of the head known as uncinate process. The uncinate process lies between the Inferior vena cava and portal vein.

The main pancreatic duct of wirsung usually traverses the entire length of the gland slightly above the line, halfway between the superior and inferior edges and normally ends by joining the common bileduct. The accessory duct of santorini branches out from the pancreatic duct in the neck of the pancreas and empties into the duodenum about 2.5 cm above the duodenal papillae. Sometimes the anomalous common hepatic artery and right hepatic artery may pass posterior to the portal vein awareness of this anomaly is useful for dissection of the portal triad to minimize inadvertent injury.

KIDNEYS

The kidney lies high up on the posterior abdominal wall behind the peritoneum, largely under cover of the costal margin. Each kidney lies obliquely, with its long axis parallel with the lateral border of psoas major. Normal kidney measures about 12x6x3 cms and weighs about 130 gms. The hilum of the right kidney lies just below and the hilum of the left just above

the transpyloric plane, 5cm from the midline. The relation of kidney posteriorly mostly the diaphragm and the quadratus lumborum muscles with overlaps medially on to psoas and laterally or to transversus abdominis. The right supra renal gland pyramidal inshape surmounts the upper pole of right kidney whereas the left supra renal is cresentric in shape and is applied to the medial border above the hilum. The anterior relation of the right kidney are duodenum, hepatic flexure, coils of jejunum and liver whereas the anterior relations of the left kidney include the tail of the pancreas, splenic flexure and stomach. The perinephric fat lies outside the renal capsule. At the hilum vein, artery and the pelvis lies in the order from anterior to posterior. The constant anatomy of the origin of the renal arteries on both sides, which is posterior to the point at which two left renal vein joints the inferiorvenacava. This is very important in controlling the renal pedicle initially before the Gerota's fascia is opened.

URETERS

The ureter is 25cm long. The ureter passes down on the psoas major under cover of the peritoneum and crosses the genitofemoral nerve being itself crossed superficially by the gonadal vessels. On the right the upper part is behind the duodenum, while lower down it is crossed by the root of the mesentery and by the right colic, ileocolic and superior mesenteric vessels. On

the left it is lateral to the inferior mesenteric vessels and is crossed by the left colic vessels and the sigmoid mesocolon. The blood supply is endangered if the ureter is stripped of the surrounding tissues.

COLON

The right colon is derived from the midgut and is supplied by the superior mesenteric artery, where as the left colon originates from the hind gut and is supplied by the Inferior mesenteric vessels. The Right colon has a thin wall and larger lumen and left colon is thicker and more muscular and has a smaller lumen. The right colon absorbs and dehydrates the small bowel contents whereas the left colon functions primarily for storage. Despite the fact that there are definite anatomical and physiological differences between the right and left colon both should be treated similarly.

RETROPERITIONEAL SPACE

The Area of the posterior abdominal wall behind the peritoneum that is not occupied by the major viscera and great vessels. Major structure lie on the posterior abdominal wall behind the peritoneum includes the aorta and inferior vene cava with a number of their branches and tributaries, the cysterna chyli, lymphnodes and nerves including the sympathetic trunk, the kidney’s, ureters, pancreas and most of the duodenum and supra renal glands.

Having discussed the anatomy of various abdominal organs. It is important to discuss about the Clinicopathological aspects and management of penetrating abdominal organs in general, recommended by various publications.

PATHO PHYSIOLOGY AND MANAGEMENT

LIVER INJURIES[25,31]

Liver is frequently injured in both blunt and penetrating trauma. Because of its size, injuries sufficient to lacerate liver are associated with injuries to other organs in about 80% cases. 85% of liver injuries are not bleeding at the time of laparotomy and patient tolerate these injuries very well[25]. Most liver injuries will infact require only documentation and no drainage. The minority of liver injuries therefore require definitive surgical care. The history of injury is helpful in that particularly any penetrating injury to the right rib cage or upper abdomen and a patient, who has a history of being in shock at eh scene following blunt trauma abdomen should be suspected of having a major liver injury.

GRADING OF HEPATIC INJURIES[31]

(Liver injury scale 1994 revision)

Grade*	Type of Injury	Description of Injury
I	Haematoma Laceration	Sub capsular <10% surface area capsular tear <1cm parenchymal depth
II	Haematoma Laceration	Sub capsular, 10-50% surface area intraparenchymal <10 cm in diameter Capsular, tear, 1-3cm parenchymal depth <10cm in length.

III	Haematoma Laceration	Subcapsular >50% surface area of ruptured Subcapsular or parenchymal haematoma, Extraparenchymal haematoma >10cm or expanding 3cm parenchymal depth
IV	Laceration	Parenchymal disruption involving 25-75% hepatic lobe or 1-3 couinaud segments
V	Laceration Vascular	Parenchymal distribution involving >75% of hepatic lobe or > 3 couinaud segments with in single lobe Juxta hepatic venous injuries i.e. retrohepatic venacava/ central major hepatic veins
VI	Vascular	Hepatic avulsion

*advance one grade for multiple injuries upto grade III

After resuscitation the patients plain x-ray abdomen should be taken and shows altered liver border, hemoperitoneum and associated rib fractures. Abdominal paracentesis is positive, if large amount of blood presents in the peritoneal cavity. DPL is diagnostic of minimal hemo peritoneum, but not specific for liver injury, CT is the investigation of choice in multiple injured patients provided patient is hemodynamically stable. Radionuclide scan are

rarely done to document location of biliary fistula after repair of hepatic injuries.

TREATMENT[31]

1. NON OPERATIVE MANAGEMENT

Indicated in

1. Hemodynamic stability
2. Normal mental status
3. Absence of a clear indication for laparotomy such as peritoneal signs
4. Low grade Liver injuries (grade 1to3)
5. Transfusion requirements of less than 2 units of blood.

These patients – followed by serial hematocrit and vital signs. During observation if the patient shows signs of bleeding angiography and selective embolisation can be done.

Indications for laparotomy during observations are

1. Continuing need for blood transfusion, increasing (or) deterioting vital signs.
2. Peritoneal signs.
3. Progressive expansion of haematoma.
4. Haematoma though to represent septic focus.

II. OPERATIVE MANAGEMENT[25,31]

(A) Simple Techniques of repair

1. Drainage of non bleeding injuries rarely performed nowadays
2. **Compression:** small cracks in the capsules can be treated by compression for 5 to 10 minutes to stop bleeding.
3. **Topical agents**: The application of gelfoam, microcrystalline collagen pad and fibrin glue is used for when avulsion of Glisson's capsule is present. After application of topical agent to the raw hepatic surface 5 minutes of compression with pads is applied. After removed electrocautery can be used for any bleeders.
4. **Suture hepatorrhaphy:** Horizontal mattress sutures with 1-0 vicryl or simple continuous suturing with 1/0 vicryl can be done with these measures most of the bleeding stops.

(B) Advanced Techniques Repair:

1. Extensive hepatorrhaphy:

If simple suturing fails to stop, multiple horizontal but bleeding from intralobar branches of hepatic artery, portal vein or hepatic vein are not controlled by this method.

2. Hepatotomy with selective vascular ligation:

It is indicated when bleeding vessels present deeply. Hepatotomy is done with finger fracture technique. Bleeding vessels and biliary radicals are identified and ligated.

3. Omental Pack

In 1975 stone and lamb first described the use of viable pedicle of omentum placed into deep lobar lacerations to control haemorrhage at the base. Viable omentum separated from transverse colon can be placed over liver laceration to control bleeding especially in bare area of liver.

4. Resectional debridement with selective vascular ligation

It is indicated whenever there is friable and partially devascularised hepatic tissue on the edge of liver or in a hepatic laceration or missile tract. It is used in preference to anatomic segmentation or lobectomy as these techniques frequently sacrifice larger amounts of normal hepatic tissue.

5. Resection

It is indicated in the case of total disruption of lobe or segment. In the form of lobectomy or segmentectomy.

6. Selective hepatic artery ligation

When selective vascular ligation fails, ligation of hepatic artery is an alternative. It may produce dramatic hemostasis without subsequent liver failure, but this should be done as close to liver as possible and only as a last resort.

7. Perihepatic packing

This technique involves the insertion of laparotomy pads or rolls of gauze around the injured liver not into hepatic laceration. Packs can be removed 12 hrs after packing. Rebleeding and sepsis are common complications.

8. Drainage

Open penrose drainage has been used after operative treatment but incidence of intra abdominal sepsis is common.

Complications:

Significant complications following liver injury includes

1. Pulmonary complications
2. Coagulopathy
3. Hypoglycaemia
4. Jaundice

5. Biliary fistulas
6. Haemobilia
7. Subdiaphragmatic and intraparenchymal abscess formation

Splenic injuries[25,31] :

The spleen is the intra abdominal organ most frequently injured in blunt trauma. In penetrating trauma wound of entry or exit in the left chest, flank or left upper abdomen should arouse suspicion of splenic injury. The clinical picture of splenic injury includes left upper quadrant abdominal pain, signs of blood loss and pain in the left shoulder (Kehr's sign).

Grading of splenic injury[31]

Spleen injury scale (1994 revision).

Grade*	Type of Injury	Description of injury
I	Haematoma Laceration	Subcapsular, <10% surface area Capsular tear <1cm parenchymal depth
II	Haematoma Laceration	Subcapsular 10-50% surface area Intra parenchymal <5cm in diameter Capsular tear, 1 to 3 cm parenchymal depth that does not involve 9 trabecular vessel.
III	Laceration	Subcapsular >50% surface area or expanding, ruptured subcapsular or parenchymal haematoma.

IV	Laceration	Laceration involving segmental or hilar vessels producing major devascularsation (>25% of spleen)
V	Laceration Vascular	Completely shattered spleen Hilar vascular injury that devascularizes spleen

* - Advance one grade for multiple injuries upto Grade III

Management

The management of splenic injury has been subject of major re-examination over the past decade and the recognition of fatal pneumococcal septicemia in patients undergoing splenectomy has led to an interest in splenic salvage (D.B.Hyot and A.R. Moossa et al)[4].

Plain abdominal films may show

1. Enlargement of splenic shadow
2. Elevation of left hemidiaphragm
3. Medical displacement of splenic shadow or stomach
4. Widening of the space between the splenic flexure and peritoneal pad.

Peritoneal lavage should be performed when there is possibility of splenic injury, positive indicates laparotomy.

Ultrasound, CT scanning and radionuclide scan can reveal grade of significant splenic injury.

I Non operative management[4,31]

>70% of all stable splenic injuries are being treated nonoperative approach.

Criteria for non operative management of splenic injury.

1. Hemodynamic stability.
2. Negative abdominal examination.
3. Absence of contrast extravasation on CT.
4. Absence of other clear indications for explorative laparotomy or associated injuries requiring a surgical intervention.
5. Absence of associated health conditions that carry on increased risk of bleeding (coagulopathy, hepatic failure, use of anticoagulants) and grade 1 to 3 injuries.

The risk of non operative management are missed injury to other viscera and delayed rupture of subcapsular haematoma. Patient are usually admitted in ICU and serial abdominal examination and haematocrit are obtained during the initial 48 to 72 hrs. The patient should be followed sequentially with CT scan.

II Spleen conserving surgery[4,22,31]

During the course of laparatomy the spleen in evaluated for haemorrhage. The repair is not attempted.

1. If it is a multiple injury case
2. Patient is in shock (systolic pressure <90mmHg)
3. There are medical contraindications to prolonged surgery (bleeding disorder, cardiac, pulmonary or hepatic disease)

If the patient condition is favourable the decision to repair is based on the state of the spleen. Generally, Grade IV and Grade V injuries are not suitable for repair whereas it can be attempted in Grade I, II and III.

Splenorhaphy[4,22,31]

The following are the techniques for splenic repair.

1. Local hemostatic agents

Gelatin foam, surgical cellulose, microfibrillar collagens thrombin, cyanoaerylate, autologous fibrin glue can be used for superficial tears which are not bleeding actively. But often pressure alone may be sufficient. Non bleeding tears are best left alone.

2. Suture repair

Deep parenchyma, tears are managed by this technique. After removal of the clot and loose devitalized tissue, the wound is inspected, arterial bleeders are controlled and the parenchyma is approximated using deep

mattress sutures. Vertical or horizontal including the fibrous capsule using absorble sutures.

3. Partial splenectomy

Polar injury which is grade IV can be managed by segmental devascularization and debridement by finger fracture technique at the line of demarcation additional security to the suture line after suture repair or partial splenectomy can be achieved by omental wrap.

4. Heterotropic auto transplantation of the splenic tissue

If the patients condition permits, the splenic function can be preserved even after splenectomy by autotransplantation at sites like gastrocolic omentum, rectus sheath and anterior abdominal wall. To be effective in preserving adequate splenic function approximately one third of the original spleen must remain and be nourished by an adequate circulation.

III Splecectomy[4,31]

Indicated in

1. Shattered or avulsed spleen
2. Severely hypotensive patients
3. Associated with other severe injuries
4. Undue delay in attempting to repair the spleen

Complications of splenectomy

1. Early transient thrombocytosis, which resolved spontaneously over 1-3 months.
2. Acute dilatation of stomach
3. Delayed haemorrhage
4. Pancreatitis
5. Subphrenic abscess
6. Left lower lobe atelectasis and pleural effusion
7. Fatal pneumococcal septicemia (Over whelming Post Splectomy Infection - OPSI)

GASTRIC INJURIES[25,31,35]

Injuries of stomach are common in penetrating – trauma but very rare in blunt trauma. The stomach is intrathoracic, partially protected by rib cage and any penetrating wound in this area should be suspected of causing injury to stomach. After resuscitation, a nasogastric tube is placed that serves both diagnostic and therapeutic functions. The return of gross blood on nasogastric aspirate is suggestive of an upper gastrointestinal injury. Haematemesis or bright red blood per nasogastric tube was present in 45% of gunshot wounds and 37% of stab wounds in series of patients with gastric injuries treated at

parkland memorial hospital[25]. The nasograstric tube also serves a therapeutic function by decompressing stomach.

OPERATIVE MANAGEMENT

The intra operative evaluation of stomach injury includes good visualisation of hiatus, evaluation of anterior portion of the stomach, division of gastrocolic ligament and complete visualization of the posterior aspect of the stomach. Penetrating wounds are debrided and primary closure performed (Moossa A.R. et al)[1,31]. Injuries with major tissue loss may be best treated by gastric resection. Post operative complications include bleeding usually from the submucosal vessels, intrabadominal abscess and more rarely gastric fistula.

DUODENAL INJURES[25,31]

The majority of duodenum injuries are caused by penetrating trauma. The incidence of duodenal injuries varies from 3% to 5%. Most of duodenal injuries are accompanied by other intraabdominal injuries.

Grade*	Type of Injury	Description of injury
I	Haematoma Laceration	Involving single portion of duodenum Partial thickness, no perforation
II	Haematoma Laceration	Involving more than one portion Disruption <50% of circumference
III	Laceration	Disruption 50% to 75% of circumference of D_2. disruption of 50% to 100% of circumference of D_1, D_3, D_4
IV	Laceration	Disruption >75% of circumference of D_2 involving ampulla or distal common bile duct.
V	Laceration Vascular	Massive disruption of duodenopancreatic complex Devascularisation of duodenum

* - Advance one grade for multiple injuries upto Grade III.

DIAGNOSIS OF DUODENAL INJURIES

Serum amylase is sensitive but unfortunately not specific for duodenal injuries. Needle paracentesis or lavage will often be positive for blood, bile or bowel contents.

Plain films of the abdomen shows

1. Mild scoliosis

2. Obliteration of the right psoas shadow
3. Absence of air in the duodenal bulb
4. Air in the retropertitoneum outlining the kidney other investigation include gastrografin upper gastrointestinal series and CT of the abdomen.

Treatment[31,35]

Intra operative evaluation of the duodenum requires an adequate mobilization of the duodenum by means of a Kocher maneuver. 80 to 85% of duodenal wounds can be primarily repaired. The remaining 15 to 20% are severe injuries that require more complex procedures.

Minor injuries (Grade I + II) diagnosed with in 6 hrs of injury, a simple primary repair is suitable. After 6 hrs, the risk of leak increases and any form of duodenal decompression like transpyloric nasogastric tube, tube jejunostomy, tube duodenostomy is advisable.

Grade III injuries are best treated by primary repair, pyloric exclusion and drainage or alternatively roux-en.Y deudenojejunostomy.

Grade IV injuries are treated by primary repair of the duodenum, repair of the common bile duct and placement of T-tube with a long transpapillary

limb or choledochoenteric anastomosis can be performed. Grade V injuries are best treated by pancreatico duodenectomy.

Most common complication after duodenal injury is the development of duodenal fistula.

PANCREATIC INJURIES[31]

Pancreatic injuries are rare accounting for 10% to 12% of all abdominal injuries. The great majority of such injuries are caused by penetrating mechanism. Major abdominal vascular injuries are present in more than 75% of cases of penetrating pancreatic trauma. Fistula, pseudocyst, pancreatitis, anastomotic leak and intraabdominal abscess occur in 1/3rd of the patients and account for the late mortality. Mortality rates ranges 10 to 25% mostly due to associated intra abdominal injuries.

GRADING OF PANCREATIC INJURY[31]

Grade*	Type of Injury	Description of injury
I	Haematoma	Minor contusion without duct injury
	Laceration	Superficial laceration without duct injury
II	Haematoma	Major contusion without duct injury or tissue loss
	Laceration	Major laceration without duct injury or tissue loss

III	Laceration	Distal transaction or parenchymal injury involving ampulla
IV	Laceration	Proximal transaction or parenchymal injury involving ampulla
V	Laceration	Massive disruption of pancreatic head

* - Advance one grade for multiple injuries upto Grade III

Diagnosis of pancreatic injuries

1. Increased level of serum and urinary amylase after blunt injury are not diagnostic, but a persistent elevation suggest pancreatic injury.
2. Contrast duodenography may reveal widening of the ‘C” loop.
3. Abdominal CT scan are currently reported as having a sensitivity and specificity in excess of 80% (Jefery KB et al, 1983)[19].
4. ERCP is the most useful in pre operative delineation of ductal anatomy in patients with delayed presentation or missed injuries (Whitwell et al, 1989).

Treatment

Pancreatic injuries are divided into proximal distal according to the location on the right or left of the superior mesenteric vessels.

1. Penetrating wounds to the right of the superior mesenteric vein should be treated with debridement and direct suture ligation of areas of bleeding.
2. Extensive injuries to the pancreatic head or to the right of superior mesenteric vessels best treated by external drainage.
3. Severe trauma to the duodenum and head of pancrease may be treated with debridement of the pancreas, closure of the duodenal wound and pyloric exclusion with external drainage.
4. Most distal pancreatic injuries with suspected ductal injuries were treated by distal resection with or without splenectomy.

The most common complication after pancreatic trauma are pancreatic fistula and peripancreatic abscess.

SMALL BOWEL INJURIES

Injuries of small bowel are present in approximately 25 to 30% of the patients who require laparotomy after penetrating trauma (Moossa et al)[1]. Stab injuries are usually less severe than gunshot or blunt mechanism of injury. In most patients who sustain stab wounds the small bowel is spared because the mobility of small bowel afforded by the redundant mesentery, allows the intestine to slide away from an offending knife blade[20].

EVALUATION AND DIAGNOSIS[31,35]

Although history and physical examination are valuable in the diagnosis of small bowel injury following penetrating trauma.

1. Plain films of the abdomen may reveal free air
2. Any patients who has peritoneal signs or hemodynamically unstable proceeds promptly to exploratory laparotomy. In equivocal cases peritoneal lavage is employed and look for indicators of hollow visceral injury like presence of bacteria, food fibres or bile and other criteria like amylase greater than 200, WBC >500/mm^3 and RBC>100,000/mm^3. Gunshot wound present a much greater risk for significant intra abdominal injury.

Treatment

At laparotomy a careful examination of the entire small bowel should be performed. Bleeding should be initially controlled and clamps or sutures should be applied to prevent further leakage of intestinal contents into the peritoneal cavity.

Penetrating injuries caused by firearms should be debrided and usually small tears closed primarily. Extensive lacerations, devascularised segments or multiple lacerations in a short. Segment of bowel are better treated by resection and reanastomosis.

Complications

Intra abdominal abscess, anastomatic leakage, enterocutaneous fistula and intestinal obstruction.

COLONIC INJURIES[25,31,35]

Colon injuries are usually the result of penetrating trauma. The colon is the second most frequently injured organ after gunshot wounds and the third after stab wounds to the abdomen. Morbidity rates after colonic injuries vary from 20% to 35% and mortality rates from 3% to 15%.

Treatment

General criteria for primary repair include

1. Early diagnosis (within 4 to 6 hrs)
2. Absence of prolonged shock or hypotension
3. Absence of gross contamination of the peritoneal cavity
4. Absence of associated colonic vascular injury
5. Less than 6 units of blood transfusion
6. No requirement for the use of mesh to permanently close the abdominal wall.

Stab and low velocity wounds to the colon with minimal contamination and hemodynamic stability can be managed by primary repair.

High risk colon injuries or those associated with severe injuries will benefit from resection and colostomy.

Post operative complications

1. Abscess formation
2. Anastomotic leak
3. Peristomal hernia
4. Morbidity and mortality associated with colostomy closure

RENAL INJURIES[32]

Penetrating trauma accounts for 84% of renal injuries. The great majority of penetrating renal injuries were gunshot wounds (99%) and the remainder were due to stabbing. Gunshot injuries produce multiple intraabdominal and intrathoracic injuries. Stab wounds to the kidney also were associated with a high incidence of non renal injuries. The overt mechanism of renal injury from penetrating trauma is the obvious tissue disruption to the parenchyma, collecting system and vasculature.

Diagnosis

History is very important a high index of suspicion should be there, flank pain, haematoma warrants evaluation regardless of the apparent location of trauma. Ground glass density in the flank suggest urinary extravasation or

haematoma or preexisting mass such as hydronephrosis or tumor. Infusion pyelography identifies approximately 80% renal injuries.

Renal injury is suggested by the following radiological findings[31,32]

a. Decreased excretion of contrast
b. Obliteration of psoas shadow or renal outline
c. Scoliosis away from the injury
d. Extravasation of the contrast.

A normal IVU with haematuria in a trauma patient suggest minor renal contusion and rules out major renal injury. Incomplete or poor visualisation of a portion of kidney suggest major renal trauma, include deep laceration avulsion or vascular occlusion. Non visualisation of a kidney on pyelography require immediate arteriography whenever possible. CT is very useful investigation helpful in the non operative management.

Treatment[32]

Surgical exploration of all penetrating renal injuries is recommended because of the high incidence of associated intra abdominal injuries. Penetrating wounds causing small parenchymal injuries are generally treated with debridement, primary repair and drainage.

- More extensive wound may require a particular total nephrectomy.

- Injuries involving the hilum are seldom repaired primarily and in most circumstances a total nephrectomy is necessary.
- Renal vein laceration may be repaired by venorraphy. Renal arterial trauma may require a variety of repairs. Lateral arteriorrphy, arterial resection and repair by primary reanastomosis or autogenous repair.

URETERIC INJURIES[31,32]

The following classification of ureteral injury helps in organising the management of ureteral injury

1. Site; upper, middle and lower third
2. Time of recognition: immediate or delayed
3. Nature of injury: blunt trauma with laceration or avulsion, penetrating trauma
4. Presence of concomitant injuries

Injury to the ureter is an common and occurs mostly after penetrating trauma. The presence of haematuria in ureteral injury is the exception rather than the rule.

Diagnosis of ureteric injury

In the majority of cases, intra venous pyelography will confirm the diagnosis. In 15% to 20% of ureteral injuries a retrograde ureterography will

be required to confirm the diagnosis. In hemodynamically unstable patients the diagnosis of ureteral injury may be made at the time of laparotomy by intravenously injecting 5ml of methylene blue. CT scan is more accurate in detecting the extravasation preoperatively.

Management[31,32]

The principles of ureteral repair are adequate debridement, tension free repair, spatulated anastomosis, watertight closure, ureteral stenting and drainage. Ureteropelvic junction disruption and major urethral injuries (greater than 2cm laceration) are best treated by nephrostomy and stent after repair with fine chromic catgut sutures. Drainage should be provided. Lower urethral injuries usually require tunneled reimplantation into the bladder, if this is not possible then a flap should be turned cephaled for reconstruction (Boari and Ockerland) when major ureteral loss is present or when it is necessary not to have any ureteral leakage post operatively, one may ligate the ureter and perform nephrostomy either at the time or percutaneouly within 24 hrs. then later doing a transuretero – ureterostomy. Alternatively one may choose substitution of a segment of tapered or nontapered ileum for the ureter. Nephrectomy may be the procedure of choice when there is simultaneous injury to the colon, ureter and iliac artery or aorta.

RETROPERITONEAL HEMATOMA[25,31]

The exact incidence of retroperitoneal haematoma in patients who have suffered penetrating abdominal injuries is usually not recorded as the hematomas are simply a manifestation of a major vascular injury.

In general trauma surgeons recognize retroperitoneal haematoma in five locations.

1. Midline suprarenal.
2. Midline infra renal.
3. Lateral peri renal.
4. Lateral pelvic and portal.

Anemia and haematoma are constant findings in patients with retroperitoneal haematoma from pelvic fractures, while hematuria is much less common inpatients with haematomas caused by penetrating wounds involving vascular structures. A plain film in a patient with penetrating wound from missile will localise the site of the missile and give some indication of major retroperitoneal vascular structure has been injured.

In contrast to the management of retroperitoneal haematoma with blunt abdominal trauma, all five retroperitoneal hematomas previously listed are opened in patients with penetrating wounds. In each instance, proximal vascular control and if possible distal vascular control should be done before entering the hematoma.

THE AIM OF THE STUDY

The aim of the study is to evaluate the following aspects of penetrating abdominal injuries excluding pelvic organs.

- The incidence of penetrating injuries abdomen.
- Mode of injury.
- Clinical presentation.
- Associated organ and system involvement.
- Management.
- Prognosis.

MATERIALS AND METHODS

This study consists of all penetrating abdominal injuries admitted in the trauma ward of Government Rajaji Hospital, Madurai from January 2005 to January 2006. Once the patient is admitted the name, age, sex and mode of injury are noted. The time interval between injury and admission and time interval between admission and surgery are recorded. After resuscitating the patients and if time permits necessary investigation are carried out. In those who are operated, the operative findings and methods of management are recorded. Cases are followed up till their discharge from the hospital. If death occurs the case of death is evaluated in those patients who died before surgery the postmortem findings are noted. The above facts are recorded in a proforma prepared for this study.

OBSERVATION

The total number of patients who had sustained penetrating injuries to abdominal organs were 70. During this period total number of cases of abdominal trauma managed were 212 cases. Thus penetrating injuries to abdominal organs account for 33% of the abdominal trauma cases.

In this study of the 70 patients 56 cases were male and 14 cases were females. This gives a male to female ratio of 4:1. The high incidence of trauma in males may probably be due to the relatively high association of males in acts of violence and ventricular accidents.

Table 1: Age and Sex incidence

Age group	Male	Female	Total
<10	Nil	Nil	Nil
11-20	8	1	9
21-30	19	3	22
31-40	14	3	17
41-50	6	3	9
51-60	8	2	10
>60	1	2	3
Total	**56**	**14**	**70**

Table 1 shows the age and sex incidence in this study. The youngest patient was a fourteen year old boy who had sustained penetrating. Injuries by falling on a tree's branch. More than 50% of the patients belongs to the age group between 21-40 yrs which is the most productive part of one's life. The oldest patient was a 76 yrs old male who had sustained penetrating injuries by bull gore.

Table 2: penetrating injuries – abdomen

Nature of injury	**No of patients**
Stab injury	45
Bull gore	23
Gunshot	2
Total	**70**

Penetrating injuries : Abdomen

As given in the Table 2 stab injury is the common penetrating trauma according for 64%. There were 23 cases of bull gore injury two cases of gunshot, two cases of RTA and one case of penetrating injury due to falling on a tree's branch.

Table 3: Injury of other organs

Other injuries	No of patients
Thoracic injuries	14
Lone bone injuries	10
Head injuries	6
Others	3
Total	**33**

Injury of the other organs

Table 3 shows the associated injuries in penetrating injuries of the abdomen, fourteen patients sustained associated thoracic injuries. Ten patients had long bone fractures and six patients suffered from head injury. Two patients had facial injuries. Totally 33 patients had injuries involving other organs. This high incidence of polytrauma with penetrating injuries abdomen indicates the severity of injuries.

Table 4 The analysis of the time interval between injury and admission and admission and surgery is given in

Time Interval	Injury – Admission	Admission – surgery
<2 hours	28	20
2-4 hours	18	30
4-6 hours	13	14
6-8 hours	5	2
8-10 hours	3	1
10-12 hours	2	2
>12 hours	1	1

From the Table 4 it can be deduced 59 cases took less than 6 hrs from the time of injury to admission. The fastest to arrive was with in 30mts from the injury. The average time duration between admission and surgery was 4 hours.

Different structures affected

Structures	No of patients
Liver	15
Small bowel	12
Spleen	8
Stomach	10
Duodenum	2
Colon	10
Kidney	6
Ureter	1
Pancreas	2
Retroperitoneal	9
Diaphragm	7

Table 5 shows the different organs injured in the study. Liver injury tops list with 15 cases. This is followed by small bowel, stomach and colon accounting for 12, 10, 10 cases respectively. These were 8 cases are spleen, 2 cases are duodenal injuries. These were 6 cases are kidney, two cases are pancreas and 1 case on ureteral injuries. These were 9 cases of retroperitoneal injuries and also 7 cases of diaphragmatic injuries.

DISCUSSION

LIVER INJURIES

There were totally 15 cases of liver injury. In this 9 cases were due to stab injury and 6 cases were due to bull gore. The incidence of associated organ injuries is a significant factor in patients sustaining liver injuries. In this study only 4 cases were isolated liver injuries and remaining were associated with other organ injuries. The different ways in which the 15 cases of liver injuries were managed on follows. Application of gelfoams and suture hepatorrhaphy was done in 5 cases. In 6 cases there were no active bleeding hence no repair it was done. In other 2 cases omental pack was kept in deep lobar laceration to control bleeding. Peritoneal lavage with normal saline was done in all cases and open drainage was kept in all cases.

In this study 2 out of the 15 cased died, giving a mortality rate of 13% due to the severe associated injuries and septicemia. Three cases developed subphrenic abscess. The mortality rate at the ben Taub general hospital in Houston from 1979 to 1984 was 10 to 15%. The incidence of post operation perihepatic abscess ranges from 3.5to 22% post operative perihepatic abscess was diagnosed clinically in the patients who remained continuously febrile after 5 to 7 days and had persistent leucocytosis and foul smelling drainage

out of open drainage. All the patients were treated conservatively. Two patient developed pneumonia with hyperpyrexia and it was confirmed by x ray chest and treated conservatively. In this study no complication of biliary leak.

SPLENIC INJURY

There were totally 8 cases of splenic injury. Of these 8 cases, 5 cases were due to stab injury and 3 cases were due to bullgore injury. Whereas the series from Ben Taub General Hospital in Houston has reported an incidence of gunshot splenic injuries as 7.6% and stab injuries as 7% among penetrating splenic injuries.

In this study only 2 cases had isolated splenic injuries. 4 cases were associated with diaphragmatic injuries and one cases associated pancreatic injury with retroperitoneal haematoma, one cases were associated with stomach and small bowel injury.

In this study all the injured spleen have undergone splectomy, whereas the series from Ben Taub Hospital, Houston report 45 to 50% of injured spleen have undergone repair instead of splenectomy that too splenorrhaphy was accomplished in 51% of patients with a penetrating mechanism of injury. But only 36.7% with a blunt mechanism of injury would be expected to undergo splenorrhaphy. The grading of the splenic injury has a significant

impact on treatment. In our study out of 8 patients 6 patients were hemodynamically unstable and had associated intraabdominal injuries so were could not perform splenorrhaphy for these patients.

In this study two cases had died in the immediate post operative period due to hypovolemic shock and multiple organ failure. Four patients had fever ranging from 99°f to 102°F upto 4^{th} post operative day and one patient had consolidation of the left lower lobe. All of them were treated conservatively with antibiotics and antipyretics. Three patients had wound infection.

STOMACH INJURIES

There were totally 10 cases of stomach injuries. In this 6 cases were due to stab injuries, 3 cases were due to bullgore injuries and one case was due to accidental gunshot injury whereas the series from Ben Taub General Hospital report an incidence of gunshot stomach injuries as 17.3% and stab stomach injuries as 12.6%.

In this study isolated stomach injury was present only 3 cases. All remaining cases were associated with other organ injuries of which retroperitoneal hematoma was present 3 cases, liver injury in 2 cases, splenic injury in 1 case, duodenal injury in one case and diaphragmatic, small bowel injury in one case. Pre operatively all cases were confirmed by the passage of

bright red blood through the Rylestube and present of free air on an abdominal film. In this study in all stomach injuries, the entrance and exit sites of the penetrating wound was visualised. Then the stomach was closed in two layers utilizing an inner running row of absorble Vicryl 2/0 placed in full thickness fashion. This layer is then imbricated with a seromacular of interrupted lembert sutures using 2/0 silk. One patient after gastrorrhaphy AGJ was done. That patient died on 4^{th} post operative day due to septicemia. One more patient died of septicemia due to concomitant colonic injury. One patient developed consolidation of left lower lobe with left subphrenic abscess and two patients had wound infection post operatively both of them treated conservatively. In all cases peritoneal irrigation was done with normal saline and open drainage was kept in all cases.

DUODENAL INJURIES

These were totally two cases of duodenal injuries of which one case were due to stab injury, one of bullgore injury. Whereas Ivatuary RR et al, Levinson MA et al give the following figures gunshot (78%), stab injuries (16%) and shot gun (6%). According to six recent series the incidence of penetrating duodenal injury was 85% and blunt duodenal trauma was 15%.

All patients were taken up for explorative laparotomy. All patients underwent duodenorrhaphy in two layers. One patient underwent a

gastrojejunostomy with pyloric exclusion. Another patient treated with serosal jejunal patch. John A Weigelt also states that 80% of patients with duodenal injuries require simple duodenorrhaphy.

In this study one case died on 4th postoperatively due to septicemia and concomitant liver and colonic injuries.

But this may not reflect the real problem because the number of cases studied were toosmall, Levison et al in a recent series reports a mortality of 16.7% for blunt duodenal trauma and a mortality of 7.5% for penetrating duodenal trauma.

PANCREATIC INJURIES

There were totally 2 cases of pancreatic injury of which one case were due to stab injuries and one case was due to bull gore injury. Gregory J. Jurkovich states that penetrating trauma accounts for two third and blunt trauma accounts for one third of pancreatic injuries.

The patient was treated with debridement, hemostasis and drainage. Another patient who had multiple stab injury of the bowel with pancreatic injury, had surgery done outside and was referred to our center with enterocutaneous and pancreatic fistula. In this study the mortality rate for

pancreatic injury was 50%. The combined mortality from several large series of pancreatic trauma patients range from 10-25% our morbidity rate was 50%.

SMALL BOWEL INJURIES

There were totally 12 cases of small bowel injuries of which 8 cases were due to stab injury and 3 cases were due to bullgore injury and one case was due to accidental gun shot injury. Whereas the incidence of small intestinal injury following penetrating trauma exceeds 80% in gunshot wound and 30% with stab injuries that penetrate the peritoneum.

In this study only 5 cases had isolated small bowel injury. In the remaining 3 cases had associated mesenteric tears, 2 cases were associated with colonic injuries and one case were associated with liver, spleen and stomach injuries.

After laparotomy thorough search for wounds from the ligament of Treitz to the Ileocecal valve was done in all small bowel injuries. In this study 8 cases were resection and anastomosis done. Two cases are treated by primary closure. In all cases thorough peritoneal irrigation with saline and open drainage was kept. In this study one patient was died due to concomitant colonic injury. In our study two patients had wound infection and two had

intraabdominal abscess both of them were treated with conservative management.

COLONIC INJURIES

These were 10 cases of colonic injuries. 8 cases were due to stab injuries, 2 cases were due to bull gore injury. In this study four patients had tear in the transverse colon primary repair and defunctioning colostomy done. Two patients had ascending colon tear and one patient had hepatic fleure tear why treated by primary closure in two layers. One patient was a diabetic who had sustained multiple stab injuries in the abdomen. These was injury to caecum, ascending colon and ileum. The injuries were repaired and tube cecostomy was done patient died on the second day due to severe sepsis. One patient had injury to transverse colon duodenum and liver. All injuries were repaired and defunctioning colostomy was done, patient expired on 4^{th} post operative day due to septicemia. One patient had injury to sigmoid colon and was treated by Hartmann's procedure. Restoration anastomosis done after 6 weeks to this patients. In all cases thorough peritoneal irrigation and open drainage was kept. In this study 8 patients had wound infection post operatively and treated conservatively.

RENAL INJURIES

There were totally 6 cases of renal injuries. Three cases were due to stab injuries and three cases were due to bullgore injuries. Whereas the commonest cause of penetrating renal trauma in the Parkland Memorial Hospital study was gunshot wounds accounting for 79% and remaining were due to stab injury.

The incidence of associated organ injuries is a significant factor in patients sustaining renal trauma. In this study all penetrating renal trauma had associated organ injuries. Carlton and associates reported an incidence of non renal surgeries of 81% in penetrating renal trauma. In recent series from Parkland Memorial hospital the incidence of non renal injuries. In patients with blunt renal trauma was 100%. The different ways in which the 6 cases of renal injuries were managed as follows. Nephrectomy was done in one patient due to hilar and pedicle injury. Three had class I injuries and the laceration was sutured and hemostasis was obtained. In two patients, the renal injury was made out only at autopsy because that patient sustained severe non renal injury.

In this study 2 out of the 6 patients died giving a mortality rate of 33% due to the severe associated non renal injuries. The mortality rate in Parkland Memorial hospital Dallas for renal trauma was 10%.

URETERIC INJURY

These were one case of ureteric injury was due to stab injury. In this case the ureteric injury was made out at the initial laparotomy and hence repaired primarily after keeping a double ‘J’ Stent and drained the site of anastomosis externally. This type of management has also been recommended by Hoch et al. in this study there was no mortality in the ureteric injuries.

RETROPERITONEAL HAEMATOMA

These were 9 cases of mild retroperitoneal haematoma with non expanding which were associated with other injuries. Nothing specific was done for these hematomas. All patients had uneventful recovery.

DIAPHRAGMATIC INJURIES

These were totally 7 cases of diaphragmatic injuries. Of which 5 cases were due to stab injury and 2 cases were due to bullgore injury. All cases were associated with intra abdominal injuries of which 4 cases were splenic injuries. 2 cases were associated with combined stomach and splenic injuries and 3 cases were associated with liver injuries.

In this study after laparotomy the rent was closed with horizontal mattress sutures with no.1 prolane. In all cases ICD was done after closure.

NEGATIVE LAPAROTOMIES

In this study, these were 14 cases of negative laparotomies. Whereas in Feliciano et al, Shorr et al series, the negative laparotomy was from 5.8% to 7.4%. In this study after confirmation of peritoneal penetration by wound exploration, explorative laparotomy was done in all cases. There was no viscus or vascular injury and there was no missed injury in our study. All were discharged after an uneventful post operative period.

MORTALITY AND MORBIDITY

These were totally 11 deaths in this study of 70 cases constituting a mortality rate of 15%. Morbidity in mild to severe forms occurred in all patients who survived.

The break up of the death cases is as follows:

Duodenal injury	:	1
Renal injury	:	2
Pancreatic injury	:	1
Colonic injury	:	2
Retrohepatic venous injury with severe liver laceration	:	2
Others	:	3

In the two cases of death due to colonic injury, the cause of death was mainly due to septicemia. In one case, there was a ascending colon injury in a diabetic patient and died due to sepsis. In other case of stab injury, there was transverse colon injury associated with liver. Spleen and duodenal injury and patient expired on 4th post operative day due to septicemia.

In the two cases of death due to renal injuries, the cause of death was mainly due to the associated non renal injuries producing hypovolemic shock. In one case of stab injury it was associated with splenic injury and the patient was brought to in late. In other case patient expired due to shock and haemorrhage autopsy revealed injuries to kidney, small bowel, mesentry and liver.

Among the pancreatic injury deaths in this were operated outside and referred after complications supervined and patient died due to septicemia.

The two cases of retrohepatic venous injuries with deep liver laceration had an intraoperative death because of hypovolemic shock secondary to bleeding.

In the remaining three cases one case of gun shot injury had multiple small bowel and large bowel perforation and resection anastomosis done and the patient developed faecal fistula and expired on the 9th post operative day.

One case of splenic injury patient died of associated head injury which was confirmed by autopsy. In other case of small bowel injury patient died of wound infection and septicemia due to concomitant colonic and stomach injury.

The severe degree of morbidity occurred in the form of residual abscess, fistula and post operative lung infections etc. The mild form of morbidity were due to wound infection.

In our study the mortality rate was 15% and it included only those patients arriving to the hospital alive. Hence the prehospital mortality having been excluded and 15% mortality rate is comparable with literature.

CONCLUSION

- Penetrating abdominal injuries constitute 33% of the abdominal injuries.
- In my study stab injury is the common mode of producing penetrating abdominal injuries.
- In this study more than 50% of the patients belong to the age group between 26-40 yrs which is the most productive part of one's life.
- In this study male to female ratio is 4:1 and high incidence of trauma in male may probably due to relatively high association of males in acts of violence and vehicular accidents.
- Liver, small bowel, colon and spleen are most frequently injured organs.
- There was no appreciable delay in the management of majority of the patients because of the penetrating nature of injuries.
- Pancreatic injuries had delayed presentations in this study.
- Multiple organ injuries were the rule in retroperitoneal trauma.
- The overall mortality of penetrating abdominal injures in this study was 15% and morbidity was 76%.
- Hypovolemic shock due to bleeding and sepsis were the major causes of death. P

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PROFORMA

PENETRATING INJURIES : ABDOMEN

Name Age: Sex:

Occupation :

Date and time of Injury :

Date and time of Admission :

Nature of injury : Stab bull gore RTA Others

Clinical parameters on admission :

Consciousness Pulse BP Respiration CVS Urine output

Abdominal Findings :

Associated Injuries :

Head Injury Thoracic Fractures Others

Investigation :

Urine HB Blood Urea Blood Grouping

Blood Sugar Serum Amylase Radiological Findings

No. of Blood transfusions :

Date and time of surgery :

Time interval between injury and surgery:

Operative findings :

Procedure done :

Post operative period :

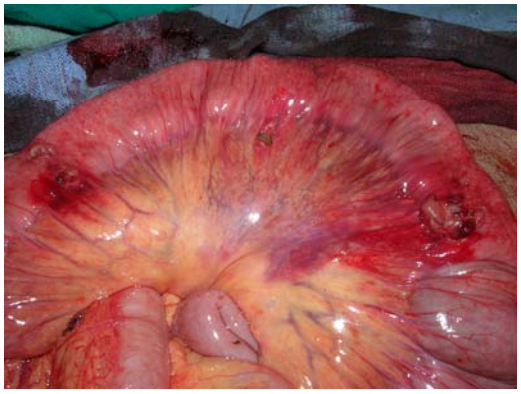
Complication and its management :

Post mortem findings in case of death:

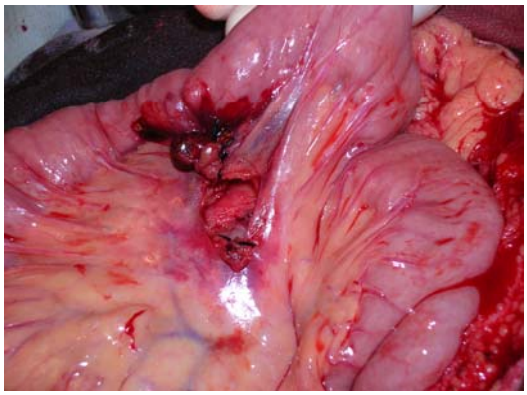
STAB INJURY LEFT ILIAC FOSSA

STAB INJURY - UMBILICAL REGION

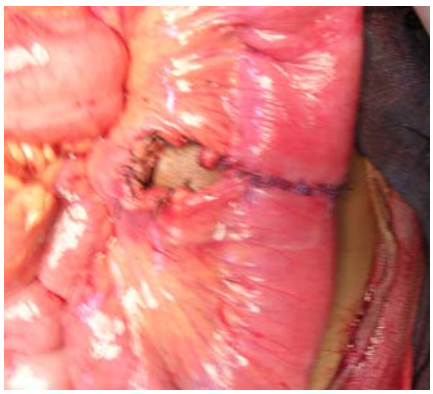
MULTIPLE TEAR IN ILEUM AND MESENTERY



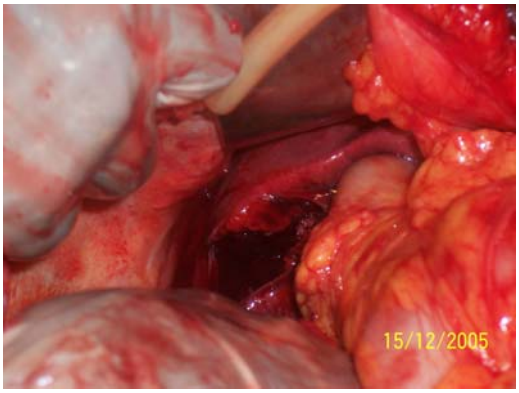
MESENTERIC TEAR



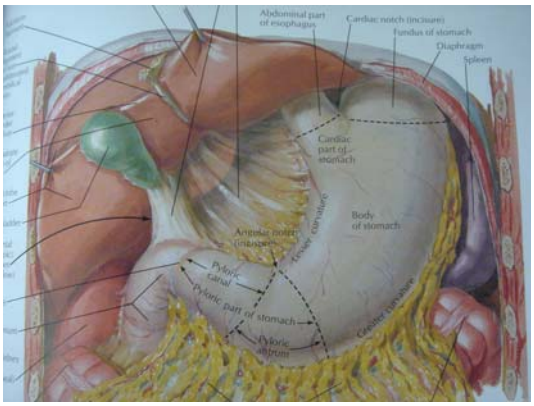
RESECTION AND TWO LAYER ANASTOMOSIS



LIVER LACERATION



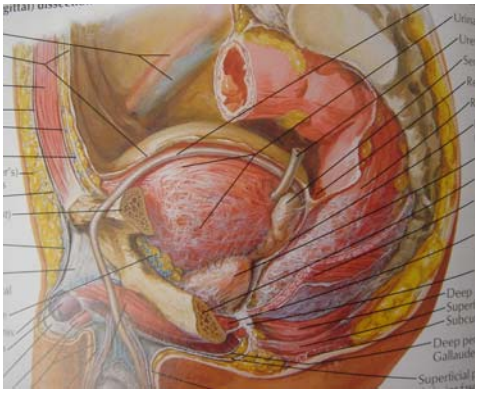
THORACIC ABDOMEN



RETROPERITONEAL ABDOMEN

PELVIC ABDOMEN

MALE

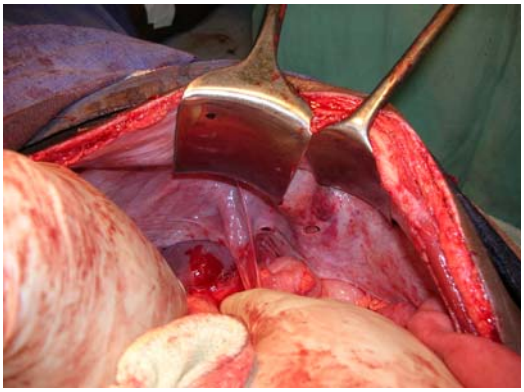


FEMALE

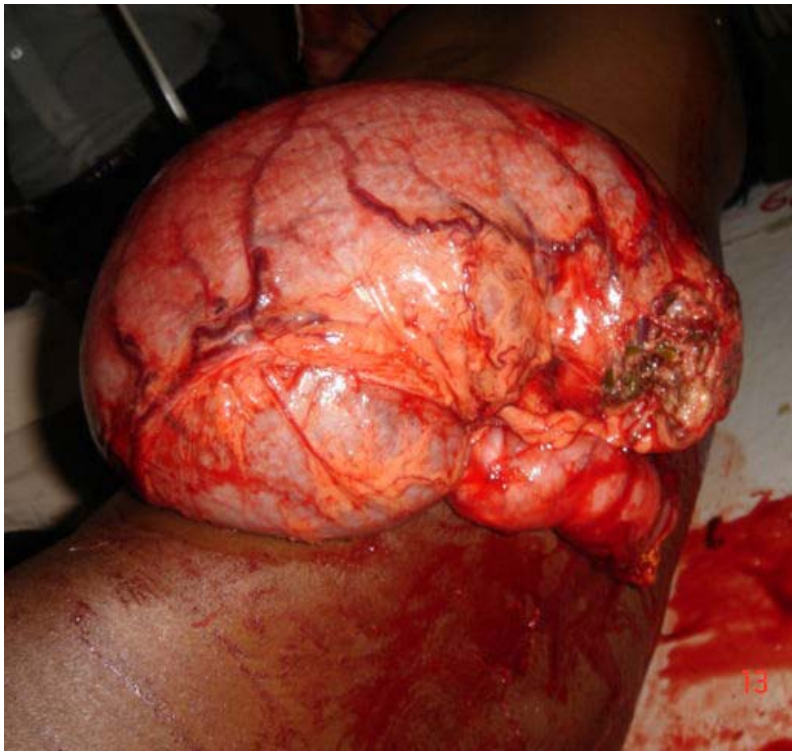
STAB INJURY LEFT ILIAC FOSSA - PROLAPSED SMALL BOWEL WITH TRANSVERSE COLON

STAB INJURY LEFT HYPOCHONDRIUM

TEAR IN DIAPHRAGM AND SPLEEN



STAB INJURY - LEFT HYPOCHONDRIUM
PROLAPSED STOMACH



STAB INJURY - UMBILICAL REGION
PROLAPSED SMALL INTESTINE

BULL GORE - EPIGASTRIC REGION
PROLAPSED STOMACH

TEAR IN ANTERIOR WALL OF STOMACH

PRIMARY TWO LAYER CLOSURE DONE